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Notes:

1. Use Scantron form to mark your answers for questions 1-50.
2. This is a closed-book, closed-note test.
3. Make sure you write your name on the Scantron form and at least pages 7 & 8 of the test.
4. Turn in the Scantron form and **ONLY** pages 7 & 8 of your test (keep the other pages to check your answers on the web).
5. You may turn in a SASE if you wish your grade mailed to you.
6. The blanks in front of each multiple-choice question are for you to mark your answers before transferring them to the scantron sheet, if you wish. If you use these blanks, you may then compare your answers to the key after the exam is over. The key will eventually be posted on Bryant's web site.
7. Mark the **one best** answer to each multiple-choice question on your Scantron.

- b   1. [Ch. 14.1] Which of the following principles of biological classification represents evoluassification, specifically taking ancestor-descendant relationships into account? a. phenetic b. phylogenetic c. cladistic d. evolutionary taxonomy (there are only two main principles, so no c, d, or e choices for this question)
- a   2. [Ch. 14.2] The classification of organisms by similarity of appearance constitutes: a. phenetics b. cladistics c. evolutionary taxonomy d. divergence e. phenetic phylogenetics
- a   3. [Ch 14.3-4] Which of the following has the advantage that it is not subject to revision by new phylogenetic ideas, but also has the disadvantage that there is more than one way of measuring, and that they can disagree? a. phenetics b. cladistics c. evolutionary taxonomy d. divergence e. phenetic phylogenetics
- a   4. [Ch. 14.5] Since only one real phylogenetic tree exists for living organisms, which of the following is unambiguous in theory (if not always in practice)? a. cladism b. pheneticism c. phyletic gradualism d. punctuated equilibrium e. evolutionary classification/taxonomy
- e   5. [Ch. 14.6] Which of the following avoids some of the extraordinary properties of cladism (such as putting humans in the lungfish clade), but suffers from some of the ambiguity of phenetics, even though it excludes convergence but doesn't exclude differential divergence? a. phylomeiotics b. pheneticism c. phyletic gradualism d. punctuated equilibrium e. evolutionary classification/taxonomy
- a   6. [Ch. 14.7] Probably because competition is stronger between more similar forms, and evolution proceeds in small stages, and variation is undirected, living things show a particular pattern of evolutionary relationships. This pattern is: a. diverging and tree-like b. converging and diamond-shaped c. linear d. circular e. log-linear
- c   7. [Ch. 15.1] Field identification of species is usually accomplished by: a. cladistic analysis b. phenetic analysis c. a few reliable external characteristics d. using the biological species concept e. determining which individuals fit into which niches
- a   8. [Ch. 15.2] A set of organisms sufficiently similar to one another is one way of stating which of the following species concepts? a. phenetic b. ecological c. recognition d. cladistic e. none of the preceding

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- e 9. [Ch. 15.3] A set of interbreeding forms with isolating mechanisms preventing breeding with other such groups is one way of stating which of the following species concepts? a. phenetic b. ecological c. recognition d. cladistic e. none of the preceding
- c 10. [Ch. 15.4] A set of organisms who recognize each other as potential mates constitutes which of the following species concepts? a. phenetic b. ecological c. recognition d. cladistic e. none of the preceding
- b 11. [Ch. 15.5] A set of organisms adapted to a particular niche is one way of stating which of the following species concepts? a. phenetic b. ecological c. recognition d. cladistic e. none of the preceding
- d 12. [Ch. 15.7] The members of a evolutionary lineage between two branch points is one way of stating which of the following species concepts? a. phenetic b. ecological c. recognition d. cladistic e. none of the preceding
- a 13. [Ch. 16.2] If new species evolve from geographically isolated subpopulations, which type of speciation has happened? a. allopatric b. parapatric c. orthopatric d. sympatric e. none of the preceding
- a 14. [Ch. 16.3] In terrestrial vertebrates, at least, the majority of species evolve by which of the following types of speciation? a. allopatric b. parapatric c. orthopatric d. sympatric e. none of the preceding
- d 15. [Ch. 16.7] A factor which establishes strong positive assortative mating among genotypes within a species range would predispose the species for which of the following types of speciation? a. allopatric b. parapatric c. orthopatric d. sympatric e. none of the preceding
- a 16. [Ch. 16.8] Many new plant species have evolved quickly by which of the following processes? a. hybridization followed by polyploidy b. inversion heterozygosity c. stabilizing selection d. polyploidy followed by hybridization e. character displacement
- e 17. [Ch 16.9] The enhancement of reproductive isolation by natural selection is called: a. character displacement b. allopolyploidy c. clinal interbreeding d. postzygotic isolation e. reinforcement
- c 18. [Ch. 16.12] New species, at least in fruit flies, but also more generally, take about how long to evolve? a. ten thousand years b. 100 thousand years c. a million years d. 10 million years e. 100 million years
- c 19. [Ch. 18.2] Based on the similarity of bird and mammal species, and due to vicariance events, the world can be divided into how many main faunal regions? (These are the Nearctic, etc.) a. 2 b. 4 c. 6 d. 8 e. 10
- b 20. [Ch. 18.3] Besides the historical reasons determining where a species exists, what other main factor sets limits on where species live? a. a species' cladistic properties b. a species' ecological properties c. a species' vicariance history d. a species' dispersal history e. a species' incongruent area cladogram
- e 21. [Ch. 18.4] The distributions of species are influenced by ecological tolerances and which of the following: a. area cladograms b. the six faunal regions of the world c. congruent biogeographic patterns d. recolonization e. historical accidents

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- \_\_b\_\_ 22. [Ch. 18.5] The splitting of a species range by a geographic/geological event is called: a. an area cladogram b. vicariance c. a congruent biogeographic pattern d. recolonization e. an historical accident
- \_\_a\_\_ 23. [Ch. 18.8] If the taxonomic cladogram matches the geological history of an area, this is evidence that which of the following occurred? a. vicariance b. dispersal c. natural selection d. mutation e. none of the preceding
- \_\_b\_\_ 24. [Ch. 18.9] The end result of the formation of the Isthmus of Panama about 3 Ma was that: a. the South American mammals essentially took over North America b. the North American mammals essentially took over South America c. there was an equal exchange — both continents now have large proportions of mammals from the other d. essentially no mammals went from one continent to the other e. none of the preceding
- \_\_e\_\_ 25. [Ch 20.1] Evolutionary rates are often measured in "darwins". To calculate this, one does what with measurements of character values? a. uses a cosine transformation b. uses a sine transformation c. raises each value to the power "e" d. divides each value by the mean of all character values in the lineage e. takes the log of each value
- \_\_a\_\_ 26. [Ch 20.2] Rates of evolution measured during artificial selection experiments in the laboratory compare how with rates of evolution measured from fossils? a. lab rates are higher than fossil rates b. lab rates are about the same as fossil rates c. lab rates are slower than fossil rates d. it totally depends on the group of organisms — in some the lab is faster, some the same, and some the lab is slower e. for prokaryotes, lab and fossil are about the same, but for eukaryotes, fossil evolution is faster
- \_\_e\_\_ 27. [Ch 20.5] The pattern of evolution whereby most change is concentrated in temporally short speciation events, with little change between speciation events, is called: a. phyletic equilibrium b. punctuated gradualism c. cladistics d. phyletic gradualism e. punctuated equilibrium
- \_\_b\_\_ 28. [Ch. 20.7] Is it yet clear that punctuated equilibrium is the way evolution works in the vast majority of cases? a. yes b. no
- \_\_b\_\_ 29. [Ch. 20.10] Is it yet clear whether the same set of evolutionary rates and processes operate at all taxonomic level or whether there are characteristic mechanisms and rates at the different levels? a. yes b. no (no c, d, or e answers for this question)
- \_\_d\_\_ 30. [Ch. 20.11] Dividing a character change into states, and studying the rate of change between states is a technique used for studying what kind of evolutionary change? a. small changes in gene frequencies b. small morphological changes, such as the size of teeth in horses c. changes in chromosome size and shape d. large morphological changes, such as limbs into wings in bats e. none of the preceding
- \_\_e\_\_ 31. [Ch. 21.1] The evolution of mammals from reptiles is an example of what kind of evolution? a. radiative b. non-adaptive c. competitive d. ecological e. adaptive
- \_\_e\_\_ 32. [Ch 21.2] The neo-Darwinian theory of the origin of higher taxa suggests that higher taxa evolve by which process: a. large, sudden changes b. vicariance c. macromutation d. polyploidy e. many small adaptive changes

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- c 33. [Ch 21.4] If terminal addition is the only type of evolution in a lineage, the organism will develop by "climbing up the family tree". This is called: a. heterochrony b. paedomorphosis c. recapitulation d. neotony e. hypermorphosis
- e 34. [Ch. 21.5] The relative timing and rate of different developmental processes can shift. This is known as: a. heterostasis b. heterosis c. heteromorphosis d. heterology e. heterochrony
- b 35. [Ch 21.6] If the time of reproduction is shifted to an earlier time relative to somatic development because reproduction is at an earlier stage, but with no change in the somatic development (besides the possible truncation of later developmental stages), we have which of the following: a. neotony b. progenesis c. acceleration d. hypermorphosis e. recapitulation
- c 36. [Ch. 21.10] Changes in the relative sizes of two organs are studied by: a. multivariate regression diagrams b. factor analysis plots c. allometric graphs d. submetric diagrams e. D'Arcy Thompson diagrams
- d 37. [Ch 22.1] The type of species coadaptation called mutualism is probably (but not necessarily) the result of which of the following processes? a. recapitulation b. reinforcement c. concerted evolution d. coevolution e. sequential evolution
- e 38. [Ch. 22.2] When insects evolve detoxification or avoidance mechanisms in response to plants' development of insecticides, we usually have the process of: a. recapitulation b. reinforcement c. concerted evolution d. coevolution e. sequential evolution
- c 39. [Ch. 22.4] If parasites have limited dispersal powers, what is the likely pattern of speciation in such parasites and their hosts? a. first the parasites speciate, then the hosts b. first the hosts speciate, then the parasites c. they will speciate virtually simultaneously d. when the hosts speciate, they evolve resistance to the parasites, and the parasites must find another host e. none of the preceding
- d 40. [Ch. 22.5] The evolution of larger brains in mammal prey and mammal predators over time has produced an escalation of brain size in both groups, though predators maintain their brain size advantage over their prey. Such escalatory coevolution is often termed: a. the Red Queen hypothesis b. punctuated equilibrium c. sequential coevolution d. an evolutionary arms race e. transient escalatory modal equievolution (TEME)
- d 41. [Ch. 22.6] The extinction rates of species are: a. positively correlated with how long a species has been in existence b. negatively correlated with how long a species has been in existence c. negatively correlated with how long a species has been in existence for species in existence generally for 10,000 years or less, and positively correlated with how long a species has been in existence for species in existence generally over 10,000 years d. uncorrelated with how long a species has been in existence e. positively correlated with how long a species has been in existence for species in existence generally for 10,000 years or less, and negatively correlated with how long a species has been in existence for species in existence generally over 10,000 years

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- a 42. [Ch. 22.7] Survivorship curves for species over time are log-linear. This implies that: a. the probability of a species going extinct is constant over time, and doesn't depend on how long the species has already been in existence; that is, species don't "grow old" b. the probability of a species going extinct increases with the time the species has already been in existence; that is, species become "senile" c. the probability of a species going extinct decreases over time; that is, species find the "fountain of youth" as they age d. the probability of a species going extinct first increases, then is constant, then decreases; there is a lot of "infant death", then a constant "middle age", and then, if a species survives into old age, it will probably hang around forever e. the probability of a species going extinct has two phases, a low phase just after speciation, and a high phase generally occurring after about a half million years have passed (at least for macroorganisms)
- c 43. [Ch. 23.1] The ecological causes of a particular species extinction are best studied in: a. species which went extinct at least 50 Ma, since the fossil record will have had time to settle down by now b. species which went extinct over 250 Ma, since it is hard to study the ecology of more recently extinct species c. modern species, since ecology is easier to study when you can actually work in the current environment d. either fossil or modern species, it really doesn't matter, but it's easier if you work with rare bacteria e. none of the preceding
- b 44. [Ch. 23.2] The taxonomic subdivision of a continuous lineage is called: a. extinction b. pseudoextinction c. punctuated equilibrium d. anomalous extinction e. more than one of the preceding
- e 45. [Ch. 23.4] If natural selection favors one form of a character in one species, and another form of the character in a different species, and if the different forms of the character cause species to have differing speciation or extinction rates, then a trend may operate to favor the kind of species with the higher speciation or lower extinction rates. This is called: a. punctuated equilibrium b. pseudoextinction c. coevolution d. macroevolution e. species selection
- c 46. [Ch. 23.8] The K-T meteorite impact crater near Chicxulub, Yucatan is now thought to be the (main) cause of the end-cretaceous mass extinction. The first evidence for this meteoric theory of mass extinction came from: a. the finding of the crater b. the dating of the crater c. the finding of large amounts of iridium at the K-T boundary d. the 26 million year cycle of Oort cloud disturbances e. none of the preceding
- d 47. [Ch. 23.9] If a mass extinction is sudden, synchronous, and global, this combination of characteristics most supports which of the following causes of the mass extinction: a. sudden volcanic activity b. rise in sea level c. climatic cooling d. meteoric impact e. changes in habitat caused by continental drift
- d 48. [Ch. 23.10] Although their results are uncertain and controversial, Raup and Sepkowski suggest which of the following? a. mass extinctions are generally due to volcanic activity, and occur about every 100 million years b. mass extinctions are generally due to volcanic activity, and occur about every 26 million years c. mass extinctions are generally due to asteroid collisions, and occur about every 100 million years d. mass extinctions are generally due to asteroid collisions, and occur about every 26 million years e. mass extinctions have no regular period and are due to a variety of different causes
- d 49. [Dawkins video] According to Richard Dawkins, phenetics can be used to classify what types of things that cladistics cannot classify? a. horses b. bacteria c. plants d. things in a desk drawer e. human languages

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\_\_d\_\_ 50. [Cronin video] According to Helena Cronin, the mixture of Darwin's own version of Darwinian theory with Mendelian genetics, and elaborated through vast areas of knowledge such as paleontology and ecology, such that the whole of biology is brought into a Darwinian understanding, is which of the following a. evolution b. cladistics c. phyletic gradualism d. modern synthesis e. none of the preceding

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**End of multiple-choice section of exam**

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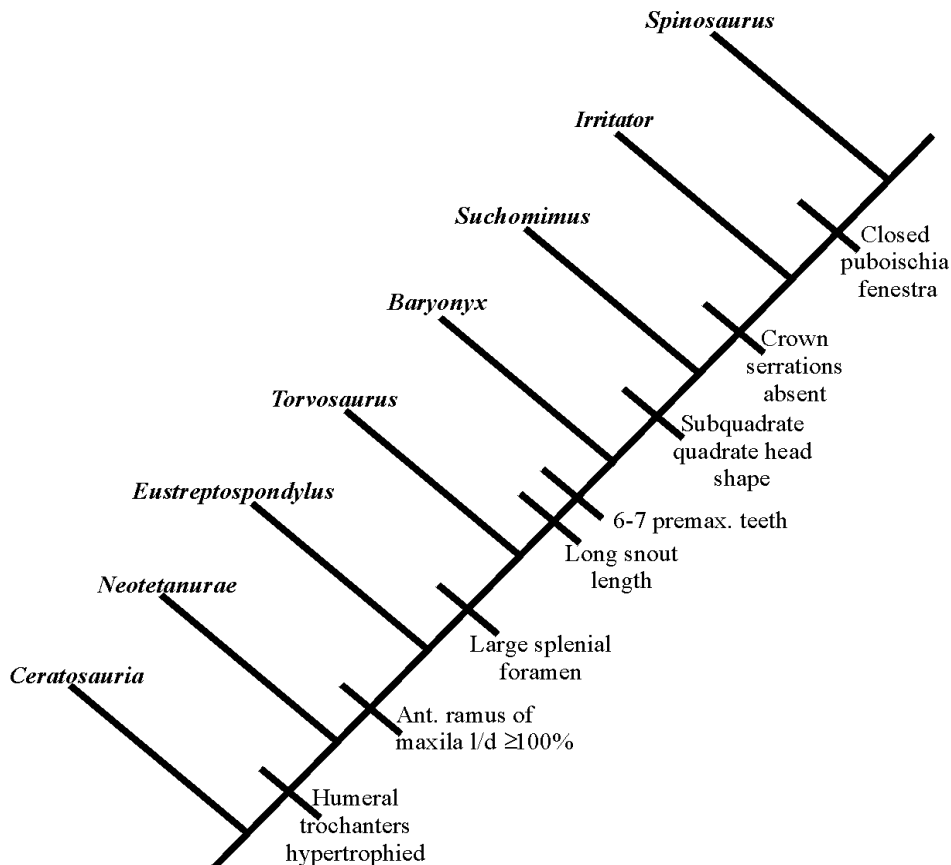
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51. (25 points) Construct a cladogram as done in class for the 7 genera of dinosaurs shown below, using *Ceratosauria* as the outgroup. Between each branch of your cladogram, write in the **COMPLETE new character STATE(s)** (such as "subquadrate quadrate head shape", "crown serrations present", or whatever) that evolved. (Modified [to unbranched cladogram, and with some character state inventions] from Sereno, P. C., et al. 1998. Science 282:1298-1302)

**MAKE SURE YOU WRITE THE FULL NAME OF THE GENUS ON EACH BRANCH OF THE CLADOGRAM, AND THAT YOU WRITE OUT IN FULL THE COMPLETE NEW CHARACTER STATE(S).**

Genus	# premax. teeth	quadrate head shape	humeral trochanters	splenic foramen	snout length	crown serrations	ant. ramus of maxilla l/d	puboischia l fenestra	# apomorphies
<i>Torvosaurus</i>	3-4	oval	hypertrophied	large	short	present	≥100%	open	3
<i>Spinosaurus</i>	6-7	subquadrate	hypertrophied	large	long	absent	≥100%	closed	8
<i>Baryonyx</i>	6-7	oval	hypertrophied	large	long	present	≥100%	open	5
<i>Eustreptospondylus</i>	3-4	oval	hypertrophied	small	short	present	≥100%	open	2
<i>Neotetanurae</i>	3-4	oval	hypertrophied	small	short	present	70%	open	1
<i>Irritator</i>	6-7	subquadrate	hypertrophied	large	long	absent	≥100%	open	7
<i>Suchomimus</i>	6-7	subquadrate	hypertrophied	large	long	present	≥100%	open	6
<i>Ceratosauria</i>	3-4	oval	low & rounded	small	short	present	70%	open	--



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52. (25 points) What is evolution? Write between 300 and 500 words, as legibly as possible. Use the back of this page if necessary. PLEASE WRITE LEGIBLY!! (Yes, I know it is difficult, you've seen me try.)

*Evolution is genetic change in a lineage, which is a group of organisms and their ancestors and/or descendants through time. The study of evolution includes the study of evidence for evolution, population genetics, adaptation and natural selection, classification, and the rates and modes of evolutionary change. The evidence for evolution includes the fossil record, which shows ever more dissimilar fossils as rocks get older; laboratory experiments which can produce new species; artificial selection experiments which produce new kinds (dogs, cats, pigeons, and flowers, for instance); evolution on a small scale in nature (such as the peppered moth and insects evolving resistance to insecticides); the imperfectness of adaptation; and homologous similarities among organisms.*

*Population genetics is the branch of genetics which studies the ways in which genetic changes may occur in lineages. Such changes have been seen in extensive laboratory experiments, and the mathematical theory is well-developed. Five major forces can cause evolutionary genetic change: selection, migration, mutation, non-random mating and genetic drift. Of these, selection, which is a difference in reproduction among individuals, is the most generally important. Selection is also the only force that can produce an adaptation, which is a feature of an organism that allows it to reproduce better than if it lacked the feature.*

*Organisms may be classified in many ways, but the cladistic method is the most generally used today. This method involves classification by shared derived traits, and defines a species as the organisms in a lineage between branching points of that lineage. Other methods of classification define species differently.*

*Fossils are traces of past life. Single-celled organisms arose at least 3.8 billion years ago, and large multi-cellular organisms arose in quantity 600 million years ago. Since then, there has been a general increase in the size and complexity of organisms on the planet. Evolution may proceed gradually with unnoticeable gradations from species to species (phyletic gradualism), or species may remain practically unchanged until a new species arises in a geologically short period of time (punctuated equilibrium). It is currently unresolved whether either phyletic gradualism or punctuated equilibrium is the case for most of evolutionary change. As far as the evidence goes, changes which result in new kingdoms, phyla or other large groupings are no different in kind than those which result in new species — macroevolution is brought about by the same processes as microevolution.*

*Species may go extinct due to competition, shifts in climate or other factors, and the majority of species that have lived on the planet are extinct. However, species do not "age"; that is, they appear to have a constant probability of extinction which does not increase with the length of time the species has existed. On occasion, many species go extinct simultaneously, which is called a mass extinction. The best studied of these, between the Mesozoic and Cenozoic, was caused by a meteorite that fell on the Yucatan Peninsula in Mexico, 65 million years ago. Probably most mass extinctions had other causes.*